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FEDERAL COMMUNICATIONS COMMISSION
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Reply to Attn of: O

MAR 1 6 1993

Ms. Donna R. Searcy
Secretary
Federal Communications Commission
1919 M Street, N. W.
Washington, DC 20554

Dear Ms. Searcy:

Enclosed are comments of the National Aeronautics and Space Administration relative to common carrier docket no. 92-297, to establish rules and policies for local multipoint distribution service using the 27.5 - 29.5GHZ band.

Sincerely,

Charles T. Force
Associate Administrator
for Space Communications

Enclosure

cc:
G/Mr. E. Frankle
C/Mr. R. Arnold

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MAR 16 1993

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of

Rulemaking to Amend Part 1 and Part 21 of the Commission's Rules to Redesignate the 27.5 - 29.5 GHz Frequency Band and to Establish Rules and Policies for Local Multipoint Distribution Service	)))))	CC Docket No. 92-297 RM-7872; RM-7722

COMMENTS OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Charles T. Force
Associate Administrator for
Space Communications
National Aeronautics and Space
Administration

March 16, 1993

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SUMMARY

NASA has a long history of developing high-risk, innovative technology for the benefit of U.S. industry and the American public. The latest communications satellite to be developed by NASA is the Advanced Communications Technology Satellite ("ACTS"), scheduled to be launched in July of this year. It will operate in the 20/30 GHz bands ("Ka-band") allocated world-wide to the Fixed-Satellite Service ("FSS") and designated in the United States for non-government use. ACTS has been designed to pioneer these bands for subsequent use by the satellite communications industry. Taxpayer investment to develop and launch the ACTS satellite and to establish an experiments program in concert with U.S. industry is about $1 billion. The payoff for this important investment will come in the form of new Ka-band satellite communications services and ensuring that the U.S. will remain the world leader in satellite communications. Development of a real ability for the commercial satellite industry to use Ka-band will help to preclude constraints on the growth of satellite communications due to eventual saturation of lower frequency bands.

NASA has conducted a technical study of the potential for sharing between the FSS and the proposed Local Multipoint Distribution Service ("LMDS") which indicates that, among other things, FSS earth stations would cause harmful interference to LMDS subscriber receivers if located in the same area. This leads to the conclusion that sharing on the basis of either frequency separation or geographic separation will not be feasible because LMDS systems would operate across the entire 27.5-29.5

GHz band and because the urban areas that are desirable for LMDS systems are the same areas that are desirable for VSAT networks. Sharing on the basis of either antenna off-axis discrimination or polarization discrimination also does not appear to be feasible. Thus, while the FSS would, in theory, retain co-primary status under the proposed rules, it would, as a practical matter, be preempted from using 80% of its allocation at 27.5-29.5 GHz (as well as in the corresponding downlink allocation at 17.7-19.7 GHz).

NASA believes that the entire 2500 MHz bandwidth allocated for FSS uplinks at Ka-band (i.e., 27.5-30.0 GHz) will be required to satisfy the anticipated commercial demand for satellite-provided services. Many new satellite applications at the threshold of commercial viability can be optimally provided at Ka-band because of the unique attributes of this part of the spectrum for certain satellite services and because there is sufficient bandwidth in this part of the spectrum to satisfy demand. In addition to satisfying anticipated demand, there are also technical reasons relating to the use of multiple spot beam antennas for coverage which dictate the need for a large amount of bandwidth in the Ka-band for wideband satellite services.

In NASA's view, the Commission did not adequately consider the impact of the proposed LMDS allocation on the FSS. If the Commission believed that it did not have sufficient information concerning FSS plans for this band in order to make such a determination, then it should have issued a notice of inquiry before proceeding to rulemaking. Had the Commission weighed such information against the comparatively weak case for allocating additional spectrum for video entertainment distribution, NASA believes it would not have come to tentative conclusion that it does in the Notice of Proposed Rulemaking (NPRM).

In NASA's view, the most prudent course for the Commission to take with respect to the future of the 28 GHz band is to monitor the ACTS experiments over the next four years and to evaluate the full range of options for the 28 GHz band in light of the results of those experiments. This will enable the Commission to properly weigh the impact of an LMDS allocation on the FSS in addition to providing the Commission with critical information that will be developed over the next few years about the future of video distribution to the home. Thus, NASA recommends that the Commission defer for five years a decision on whether to allocate spectrum in the 28 GHz band for LMDS.

If the Commission applies a balancing test here, it can only conclude that delay will best serve the public interest. On the one hand, it is difficult to see the harm in delaying the introduction of yet another video programming outlet to the market. On the other hand, failing to delay further consideration of an LMDS allocation at Ka-band will result in substantial and irreparable harm to the public because hasty action will, to a large extent, waste the approximately $1 billion taxpayer investment in ACTS. If LMDS is allowed to halt the development of Ka-band satellite technologies in the U.S. just when major strides are about to be made through the launching of ACTS, then, for virtually the first time, the U.S. will be abdicating its leadership position in a segment of the satellite industry.

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Rulemaking to Amend Part 1 and Part 21 of the Commission's Rules to Redesignate the 27.5 - 29.5 GHz Frequency Band and to Establish Rules and Policies for Local Multipoint Distribution Service	)))))	CC Docket No. 92-297 RM-7872; RM-7722

COMMENTS OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The National Aeronautics and Space Administration ("NASA") hereby submits its comments in response to the Notice of Proposed Rulemaking, Order, Tentative Decision and Order on Reconsideration ("Notice") issued in the above-captioned proceeding.

I. INTRODUCTION

Development of satellite communications by NASA began in the earliest days of the space age. The earliest work by NASA included the launch of the ECHO satellite in 1960 for experimentation of communications using passive satellites. Launch of the low-orbit RELAY active communications satellite followed in 1963. That year, NASA also launched the SYNCOM communications satellite, the first satellite to be placed in the geostationary satellite orbit. SYNCOM was followed by the Applications Technology Satellites ("ATS") 1 through 6 and by the joint NASA/Canadian Communications Technology Satellite ("CTS"). This pioneering work led to the development of a multi-billion dollar industry and to the most commercially successful application of space technology to this day. It has provided the American public with the means to receive television transmissions from anywhere in the world, revolutionized international telephony, and produced dramatic decreases in the cost of overseas telephone calls.

NASA continues to develop high-risk, innovative technology for the benefit of U.S. industry and the American public. The latest communications satellite to be developed by NASA is the Advanced Communications Technology Satellite ("ACTS"), scheduled to be launched in July of this year. It will operate in the 20/30 GHz bands ("Ka-band") allocated world-wide to the Fixed-Satellite Service ("FSS") and designated in the United States for non-government use[1]. ACTS has been designed to pioneer these bands for subsequent use by the American communications industry. Thus, ACTS will directly benefit the constituency of the FCC: American industry and the American public.

We are concerned that the reallocation proposed in the instant proceeding could preempt FSS use of 80% of the Ka-band. As explained in Section V, we have conducted a technical study of the potential for sharing between the FSS and the proposed Local Multipoint Distribution Service ("LMDS") that has produced discouraging conclusions regarding compatibility between the two services.

Our comments provide information on this study and on other factors that should be taken into account before a decision is made in this matter. We

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1 [redacted]

recommend careful consideration of all issues discussed below before rules are adopted that might radically alter the potential for delivery of communications services via satellite.

II. ACTS IS A $1 BILLION PROGRAM DESIGNED TO ADVANCE Ka-BAND TECHNOLOGY FOR THE COMMERCIAL SATELLITE INDUSTRY

NASA plans to launch ACTS in mid-1993[2]. The express purpose of this satellite program is to develop and test the high risk technology needed to keep the United States communications satellite industry preeminent in the world. Taxpayer investment in ACTS is about $1 billion.[3]

Key ACTS technologies include fast hopping spot beam antennas and on-board baseband processing. Hopping spot beam technology will: (1) make possible spectral reuse through spatial diversity; (2) allow higher communications rates with VSAT terminals (including the T1 and T3 rates); (3) permit the use of smaller earth stations; (4) facilitate efficient capacity assignment to geographically non-uniform traffic loads; (5) permit the use of small airborne terminals to transfer and process imagery; and (6) permit high data rate-thin route interconnection with the national fiber networks.

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2 ACTS will operate from 100 deg. W.L.

3 Of the $1 billion, $500 million is attributable to the ACTS satellite, $250 million for launch costs, and $100 million for the experiments program. These costs are estimated, not actual costs, and are not all inclusive.

In addition, on-board processing will: (1) introduce the ability to switch and route, on the satellite, signals at the individual voice circuit level; (2) allow single hop mesh voice networks; (3) provide improved signal-to-noise ratios; and (4) provide beam switching for very wide bandwidth computer to computer communications (600-900 Mb/s).

Development of a real ability for the commercial satellite industry to use Ka-band will, in effect, add 2.5 GHz to the bandwidth available for satellite communications and, consequently, will help to eliminate constraints on the growth of satellite communications due to eventual saturation of lower frequency bands. Dynamic rain fade compensation techniques will be developed to offset the large rain attenuation that can be expected at Ka-band.

An experiments program will be carried out over a two to four year period following launch in concert with American industry. Many of the planned industry experiments will be in the nature of test market operations to validate the future economic viability of ACTS technologies. Over 30 experimenters are already part of the program and more are expected.[4]

A complete range of experiments is planned which overlap traditional radio services. More than 25 point-to-point experiments will be conducted ranging from applications of Supervisory Control and Data Acquisition

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4 A list of participants in the ACTS experiments program is included at Appendix A.

("SCADA") for the utilities industry to linking supercomputers with the ability to interchange data at gigabit per second rates.

Applications to point-to-multipoint communications will include tests of distribution of HDTV and digital radio via satellite. Satellite news gathering experiments are also planned.

Mobile service applications will include land, aeronautical, and maritime mobile as well as personal communications. Several experiments will test the contribution of high-data rate communications to the field of emergency medicine. Other experiments will test the feasibility of satellite and satellite/terrestrial based PCN as well as hybrid satellite cellular networks.

NASA has developed T1 VSAT terminals to operate at Ka band frequencies. These terminals will play a vital role in the ACTS experiments program. Eighteen T1 VSATs are being developed, seven owned by NASA and eleven by non-NASA experimenters. There is a strong potential for up to ten additional, experimenter financed, T1 VSATs to be added to the experiments program.

Five USATs (Ultra Small Antenna Terminals) are being developed for SCADA applications. Two of these terminals will be owned by NASA while the remaining three are being developed jointly by NASA and Southern California Edison.

Five High Data Rate ("HDR") terminals are being developed jointly by NASA and the Defense Advanced Research Projects Agency (DARPA). The ACTS mobile terminal and an aeronautical mobile terminal are under development by NASA.

Ten receive-only propagation terminals will be located in various rain climatic zones in North America to characterize propagation impairments and dynamics affecting Earth-space communications at 20/30 GHz.

In all, 44 terminals with diverse capabilities are currently under development for experimentation with ACTS, and up to an additional 13 terminals could potentially be added to the program.

The ACTS experiments program takes a market-driven approach and provides a model for government/industry cooperation in the development of commercially significant space-based technologies and services. The goal is to stimulate the commercial uses of ACTS-like technologies by demonstrating feasibility through technical experiments and demonstrating telecommunication service possibilities through applications experiments.

The American taxpayers will have invested about $1 billion to develop and launch the ACTS satellite and to establish an experiments program in concert with American industry. The payoff for this important investment will come in the form of new Ka-band satellite communications services and ensuring that the U.S. will remain the world leader in satellite communications. Thus, although ACTS is an experimental system, it is clearly in the public interest to ensure that it is adequately protected and that its objectives are satisfactorily accomplished.[5] Indeed, given its importance to the future of the FSS, the public interest in this case must be considered in the broader context of the FSS in general rather than in the narrow context of protecting ACTS over the next few years.

In this connection, it is inconceivable to us that the Commission would adopt rules that could negate the major benefits that the ACTS program can provide to the country. Yet, the possibility exists for one Government agency to take action that could effectively eradicate the major benefits of a program being carried out by a sister Government agency. Thus, we strongly urge the Commission to carefully weigh the ramifications of its proposed actions and not make hasty decisions on the fate of future Ka-band satellite communications.

III. THE FULL 2500 MHz UPLINK ALLOCATION AT Ka- BAND WILL BE NEEDED TO SATISFY ANTICIPATED DEMAND FOR COMMERCIAL SATELLITE SERVICES

For the reasons explained below, NASA believes that the entire 2500 MHz bandwidth allocated for FSS uplinks at Ka-band (i.e., 27.5-30.0 GHz[6]) will

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5 NTIA, acting on behalf of NASA, has requested in a letter dated March 16, 1993 that the Commission accord protected status to ACTS.

6 The Mobile-Satellite Service currently has a secondary allocation in the 29.5-30.0 GHz band. The Commission has proposed to upgrade this to a co-primary allocation in ET Docket No. 92-191. See Notice of Proposed Rulemaking, Amendment of Section 2.106 of the Commission's Rules to Upgrade to Primary Status the Secondary Mobile-Satellite Service Allocation at 19.7-20.2 GHz and 29.5-30.0 GHz, 7 FCC Rcd 5626 (1992).

be required to satisfy the anticipated commercial demand for satellite-provided services.

Use of Ka-band did not materialize as early as once predicted, mainly because of the rapid development and deployment of terrestrial optical fiber and the diversion of point-to-point trunking from satellites to terrestrial networks. Now, there are many new satellite applications at the threshold of commercial viability that can be optimally provided at Ka-band because of the unique attributes of this part of the spectrum for certain satellite services and because there is sufficient bandwidth in this part of the spectrum to satisfy demand. NASA believes that the demonstration of unique technology that ACTS will introduce will unleash this new wave of demand. Already, the influence of ACTS technology can be seen in the plans by Norris Communications to launch its Norstar satellite.

Ka-band has unique properties that are advantageous for commercial communications applications. In this band, physically small antennas can provide high gain both on a satellite and on the Earth. Consequently, it is feasible to implement satellites with multiple spot beams, each covering a relatively small area on Earth and permitting the use of lower gain, smaller VSAT earth terminal antennas. NASA-sponsored studies conclude that the reduction in antenna size not only will result in lower costs but will permit indoor installation in many locations, thus overcoming aesthetic and zoning objections to satellite dishes and, at the same time, providing higher reliability due to a more benign environment.[7] The baseband processor to be introduced with ACTS will eliminate the need for central hub master stations. With ACTS, one master control station costing $1.5 million can be used to control a satellite handling 150,000 VSAT sites. Consequently, the distributed cost of the master control station per VSAT site is only $10 compared to the several hundred to several thousand dollars per VSAT for the central hub needed in today's networks. The same study cited above concludes that introduction of ACTS technology into the already rapidly growing general purpose VSAT market will result in a compound annual growth rate in excess of 10-20% between the years 1995 and 2000. Other applications of ACTS technology to VSATs will provide point-to-point T1 service to handle voice, data and video in niche markets.

Another case study has examined the impact that ACTS technology can have on the narrowband mobile market.[8] ACTS-like satellites will provide high-data-rate file transfer, high-quality voice, and high-resolution graphics services that will benefit sales personnel, truckers, air travelers, emergency crews working in remote areas, and others needing remote monitoring capabilities. Currently, the aeronautical, maritime, land mobile and remote monitoring services are limited due to congested spectrum space and low-data-rate technologies. Consequently, these services accommodate only a small fraction of the potential market. While

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7 Commercial Business Case-Very Small Aperture Terminal (VSAT) Network, RKM Associates, October 26, 1990.

8 Commercial Business Case - Narrowband Mobile: Air-to-Ground, Maritime, and Remote Monitoring Systems, RKM Associates, October 26, 1990.

numerous regulatory and policy hurdles must be cleared, ACTS technologies can overcome the present constraints that are artificially limiting the narrowband mobile market.

Other NASA-sponsored case studies have demonstrated that viable business entities that utilize ACTS technologies can be formed to profitably provide services to markets for:

- supercomputer access and network restoral systems;[9]
- rural electric power monitoring and operations communications systems and other SCADA communications systems;[10]
- personal communications systems for voice and ISDN;[11]

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9 Commercial Business Case - Supercomputer Access and Network Restoral Systems, RKM Associates, October 26, 1990.

10 Commercial Business Case - Rural Electric Power Monitoring and Operations Communications Systems and Other SCADA Communications Systems, RKM Associates, October 9, 1991, Revised December 10, 1991.

11 Commercial Business Case - Personal Communications Systems - Voice and ISDN, RKM Associates, October 26, 1990. A very conservative market estimate of one million users for personal communications systems will require a bandwidth on the order of 500 MHz. This estimate is based on studies of a Personal Access Satellite System ("PASS") carried out at NASA's Jet Propulsion Laboratory ("JPL"). JPL D-7382, Personal Access Satellite System (PASS) Study - Fiscal Year 1989 Results, M.K. Sue, Editor, Sept. 1990; CITEL Symposium, May, 1991, Washington, D.C., A 20/30 GHz General Satellite Service (GSS) System, M.K. Sue and V. Jamnejad. The JPL studies used a spread spectrum modulation technique, 5 MHz channels, 100 users per channel, and 20 times frequency reuse. An equivalent bandwidth of 2.5 kHz per user is required and, for a peak busy hour use factor of 10%, 250 MHz of bandwidth can accommodate one million users for communications with the space segment. Another 250 MHz would be required for feeder links to the satellite for a total bandwidth requirement of 500 MHz.

- international and domestic satellite cellular telephone networks;[12]
- high definition television, direct broadcast television, and video conferencing services;[13] and
- intelligent highway vehicle systems.[14]

In addition, LEO satellite systems are planning to use Ka-band for their feeder links. It is likely that about 500 MHz of bandwidth will be required to accommodate such links, possibly separate from the spectrum used for GEO satellite systems.[15]

Apart from demand, there are also technical reasons which dictate the need for a large amount of bandwidth in the Ka-band for satellite services. NASA believes that a commercially viable Ka-band satellite system will make use of numerous, high-gain spot beams to enable the use of physically small earth terminal antennas, to achieve frequency reuse, and

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12 Commercial Business Case - International Satellite Cellular Telephone Networks, RKM Associates, October 9, 1991; Commercial Business Case - Satellite Cellular Telephone Network (Including Personal Communications Networks), RKM Associates, October 26, 1990.

13 Commercial Business Case - High Definition Television, Direct Broadcast Television, and Video Conferencing Services, RKM Associates, October 26, 1990.

14 Future Market Overview - Intelligent Highway Vehicle Systems, RKM Associates, October 1, 1991.

15 Motorola Satellite Communications, Inc. has requested 200 MHz in the 27.5-29.5 GHz band for feeder links for its proposed Iridium system. TRW, Inc. has requested 110 MHz in the 29.5-30.0 GHz band for feeder links for its proposed Odyssey system. Although other LEO applicants have requested spectrum for feederlinks in the 5 GHz band, the Commission has tentatively decided not to authorize LEO feeder links in that band. Notice of Proposed Rulemaking and Tentative Decision, ET Docket No. 92-28, 7 FCC Rcd 6414, 6418 (1992). Thus, it is entirely possible that LEO systems other than Iridium and Odyssey would also use the Ka-band for feeder links.

to obtain sufficient rain margins. The need for isolation between these beams will result in spectrum segmentation, and significant reduction in the available spectrum per spot. Unless the overall spectrum allocation is sufficiently large, wideband applications, such as B-ISDN, will not be commercially feasible.

For a typical CONUS coverage requiring approximately 20 spots, NASA favors a repetitive seven cell hexagonal arrangement of spots which provides the necessary isolation and can achieve substantial frequency reuse. Without this technology, Ka-band would likely never be commercially viable. Unfortunately, segmenting the spectrum seven times reduces the spectrum available for a specific spot. For example, with a 500 MHz allocation, the bandwidth available for a given spot beam would only be 72 MHz. While this amount of bandwidth could conceivably be adequate for certain services, it would be woefully inadequate for wideband applications like B-ISDN and supercomputer networks.

For example, two recent studies have shown that between 1200 and 2500 MHz bandwidth is required for B-ISDN by satellite. In this connection, Space Systems/LORAL and COMSAT Laboratories completed a NASA-sponsored evaluation of two system architectures for B-ISDN services by satellite.[16] Either system architecture would provide completely

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16 Price, K.; Kwan, R.; Chitre, D.; Henderson, T.; White, L.; Morgan, W.: "Applications of Satellite Technology to Broadband ISDN Networks", Space Systems/LORAL, NASA CR 189199, March 1992.

integrated voice, data, and video services, according to the B-ISDN concept. The studies considered:

A simple repeater satellite which provided 155 Mbs interconnects between terrestrial B-ISDN nodes. This concept made use of 10 simultaneous fixed beams of 1.55° beamwidth, yielding about three times frequency reuse.

A regenerative satellite with on-board processing and switching, which provided private B-ISDN services but also allowed interconnects with the public B-ISDN system. This concept made use of 12 hopping beams, each serving 7-10 dwell locations, to support a total of 110 spots. This concept would achieve four times frequency reuse.

With both spacecraft, multibeam coverage was necessary to provide the needed capacity and link gain. System architecture (1) required an allocation of 1200 MHz whereas system architecture (2) required 2500 MHz.[17]

It should be noted that in a separate NASA-supported study, Booz-Allen & Hamilton forecast a total B-ISDN market of $2.2 billion by the year 2001,

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[17] For 30% system utilization and 8 hours of use per day for each user, user charges would be about $13.00 per minute for 155 Mbs access.

growing to $40 billion by 2011.[18] Of this amount, remote service by satellite is expected to be a $400 million market by 2011.

In summary, it is clear to NASA that the emergence of even a fraction of the potential markets that will be enabled by ACTS technologies will create a demand for wide bandwidths at Ka-band for the FSS. Based on the business case studies discussed above, the potential for Ka-band point-to-point, point-to-multipoint, and wideband services leads NASA to conclude that at least 1500 MHz of bandwidth will be needed for fixed VSAT services including wideband services such as B-ISDN and supercomputer networks.

Thus, NASA concludes that the full 2500 MHz allocated to the FSS at Ka-band could well be required to accommodate the expected growth in demand for new satellite services. 1500 MHz may be needed for fixed VSAT including wideband services. Another 500 MHz block of spectrum may be required for LEO feeder links because of possible technical incompatibilities of using a common band for both LEO and GEO satellites. Finally, 500 MHz is needed for mobile/personal communications services, both because of anticipated demand for these services, and because of the orbit/spectrum efficiencies gained by segmenting the spectrum used for hand-held communicators from that used for more traditional uses.[19]

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18 Adamson, Steven; Roberts, David; Schubert, LeRoy; Smith, Brian; Sogegian, Robert; Walters, Daniel: "Potential Markets for Advanced Satellite Communications", Draft NASA contract report, Lewis Research Center, Sept. 1992.

19 The expected proliferation of non-fixed satellite services at Ka-band will make it increasingly difficult for the Fixed-Satellite Service to use its allocation in the 29.5-30.0 GHz band, particularly if that band is reallocated to the Mobile-Satellite Service on a co-primary basis as proposed in ET Docket 92-191.

As explained in Section IV, if the 27.5-29.5 GHz band is reallocated to LMDS, the FSS will, as a practical matter, be preempted from using that spectrum, particularly in metropolitan areas. The only remaining Ka-band uplink spectrum would be at 29.5-30.0 GHz, but, as noted above, the future availability of even this 500 MHz of spectrum for FSS operations is questionable. Of course, as also noted above, even if non-fixed uses of the 29.5-30.0 GHz band do not develop, 500 MHz would still be wholly inadequate to accommodate the type of wideband satellite systems planned for Ka-band.

IV. THERE ARE SIGNIFICANT UNANSWERED QUESTIONS ABOUT THE TECHNICAL VIABILITY OF LMDS

There are significant issues associated with the design of Suite 12 Group's LMDS system that cast doubt on the technical and economic viability of the system.

The Sarnoff Report submitted with the Suite 12 Petition for Rulemaking appropriately includes margin for rain attenuation in its calculations but provides no margin for the potentially more significant factors of loss due to blockage from buildings and attenuation through foliage.

NASA propagation studies[20] carried out in connection with application to land mobile satellites measured losses due to single trees of 15 dB at L-band. Recent measurements at 20 GHz taken by the University of Texas[21] found 15-20 dB peak (intermittent, depending on receiver location) losses for transmission through the crown of a bare pecan tree. The fade through a single magnolia tree with foliage was a persistent 15-20 dB. Even higher loss is expected for transmission through the foliage of deciduous trees due to the higher moisture content of these trees. Fade margins of 30 dB could be required in clear weather and in excess of 30 dB during rain.

Measurements of attenuation at L-band due to blockage from buildings have been performed in Chicago by the University of Texas[22]. Losses of 30-40 dB were measured except where reflected signals limited the loss to about 20 dB. In the proposed LMDS design, using high-gain receiving antennas, the chance of benefiting from reflected signals appears very small.

Based on propagation factors, an LMDS system operating at 28 GHz will

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20 Goldhirsh, J. and Vogel, W., "Propagation Effects for Land mobile Satellite Systems: Overview of Experimental and Modeling Results", NASA Reference Publication 1274, February, 1992.

21 Vogel, W., Private communication, March, 1993

22 ibid.

thus require a direct, unobstructed, line-of-sight path if excessive losses are to be avoided. Yet, no showing has been made of how this will be accomplished for the majority of either urban settings (due to physical blockage from buildings) or in suburban settings (due to foliage and blockage). Rooftop antennas would be required, at a minimum. which would seem to be undesirable for the LMDS subscriber.

The filing of Suite 12 provides no analysis to show how implementation of nodes on 6 mile diameters (as discussed in the Sarnoff Report) would be achieved nor of the economic viability of doing so. It would appear that it would be difficult, at best, to find feasible sites for the many towers that would be required and that public resistance to siting of these towers could be intense. The cost of implementing cable heads in each and every cell or, alternatively, of distributing signals from a single source to each cell casts doubt about the economic viability of the LMDS.

All of the technical and economic questions about the viability of the LMDS at 27.5-29.5 GHz must be studied and answered before a decision is made on whether to reallocate the band for the LMDS. A premature decision would be disastrous to the future of the FSS without producing any mitigating benefit in the form of a viable LMDS.

V. SHARING BETWEEN THE FSS AND LMDS DOES NOT APPEAR TO BE FEASIBLE

As an initial matter, NASA notes that the documents filed by LMDS proponents provide no analysis of sharing between an LMDS system and the FSS. However, as explained below, there are three different sharing situations that must be examined.[23]

Sharing between FSS Earth Stations and LMDS Subscriber Receivers

For the reasons explained below, sharing between FSS earth stations and LMDS in the same urban area does not appear to be feasible.

The urban areas that are desirable for LMDS systems are the same areas that are desirable for FSS, particularly for VSAT terminals which are ideal for the Ka-band. LMDS users could well be located literally across the street from a VSAT terminal users, perhaps even in the same building. Considering that the eirp of a VSAT earth station in the horizontal plane will be about 11 dBW in 18 MHz while the LMDS base station transmitter eirp will be about 5 dBW in 18 MHz, such a proximity of LMDS subscribers and FSS earth stations would make sharing extremely difficult, if not impossible.

Section 21.1002(b) of the proposed rules states that licensees shall coordinate with existing users within 75 miles of an LMDS base station in order to resolve any interference problems. It is difficult to see on what

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23 These sharing situations are discussed in more detail in Appendix A.

basis coordination between an FSS earth station and an LMDS receiver could be successfully achieved. The methods by which interference problems are generally addressed, and the applicability of these methods to FSS/LMDS coordination are as follows:

- Frequency separation. Under the proposed rules, LMDS systems would operate on virtually all frequencies in the 27.5 - 29.5 GHz band. Thus, frequency separation in the shared band is not feasible.

- Antenna off-axis discrimination. Since an LMDS system could serve individual consumers, the possibility exists for every house or office building in an area to have an LMDS receiving and/or transmitting antenna. This would be particularly true of a CATV type distribution system. Under this scenario, sharing through antenna discrimination would be impossible since the subscriber antennas could be located anywhere within the service area.

- Polarization discrimination. Polarization discrimination would be virtually non-existent because the coupling between the LMDS antenna and the earth station antenna would occur through a sidelobe or backlobe of the FSS earth station antenna or the LMDS antenna.

- Geographical separation. As stated for the antenna discrimination case above, since subscribers could be located